way. On the other hand, the squirrels may have been isolated in Mill Point in the early decades of this century by unsuitable habitat in the areas to the south and east. They do seem to show a preference for certain types of exotic trees, such as palms (locations A, B, C, E and perhaps L) and pines (locations F, J, and O). I have rarely seen them in eucalypts, and it is likely that the sand plain scrub and farmland which once was found in this district would have been unattractive habitat for them. With more recent development of the land there are now unbroken stretches of residential suburb, with their improved supplies of food, water and exotic garden trees, which might allow the squirrels to gradually expand their range until their colonies are found throughout the metropolitan area.

A STUDY OF HOMING PERFORMANCE IN THE SENEGAL DOVE

By R. H. STRANGER, West Perth.

INTRODUCTION

Banding of the introduced Senegal Dove *(Streptopelia senegalensis)* in the metropolitan area of Perth has revealed that it is a highly sedentary species. Individuals were repeatedly retrapped throughout the year at their original trapping sites and 56 birds which were banded when adult (determined as such by the fully spotted plumage, and the eye and feet colouration) and recovered, throughout the year, other than by retrapping at their banding places (=B.P.) were recovered at the distances shown in Table 1.

TABLE 1.—Recoveries of banded doves at varying distances.

Recovery distance from B.P. in miles	Number of birds recovered	Percentages per distance		
0-¼	* 38	67.9		
½	† 7	12.5	80.4	
				91.2
¾	3	5.4		
1	3	5.4	10.8	
?	1	1.8		
2	1	1.8		
2¼	1	1.8	9.0	9.0
5	1	1.8		
6	1	1.8		
	=56	=100	=100	=100

N.B. 0.2% has to be deducted from the percentage columns to allow correction to 100%.

It is obvious that the adult is of a very sedentary nature, namely, that having established itself in a territory it then occupies the territory throughout the year.

*One bird was later recovered ½ a mile from B.P.
‡One bird had previously been recovered 1½ miles from B.P.

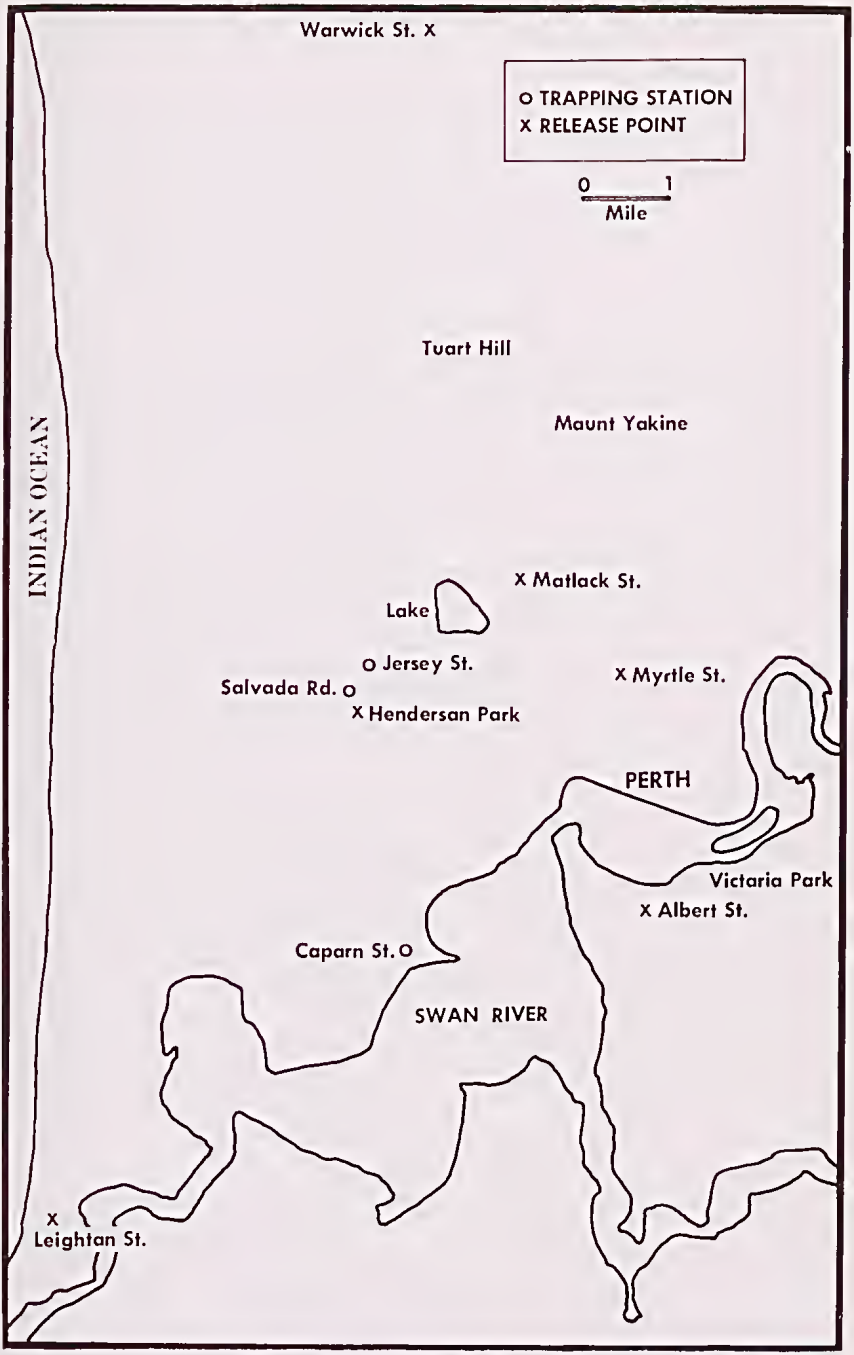

Fig. 1—Location of trapping and banding stations and of release points in the Perth metropolitan area.

Apparently the only real movement exhibited by the species takes place when some of the juveniles, after being reared, disperse and presumably colonise other or new areas. That wide extensions of range occur has been demonstrated by Sedgwick (1958, 1965). It is unlikely that the adults have much knowledge, if any, of the areas surrounding their home territories, other than that which may have been acquired during their wanderings as juveniles. It has already been established (Stranger, 1961) that individuals transported away from their home area, up to 17 miles distant, have the urge and ability to return. A summary of these and further more extensive experiments is now presented and discussed and an account of local topography and its possible effects is given.

TRAPPING AND BANDING OPERATIONS

The trapping and banding of the birds used in the experiments was conducted at three localities: the Salvado Road Station, Wembley, situated three miles W.N.W. of the Perth G.P.O.; the Jersey Street Station, situated one third of a mile N.E. of the Salvado Road Station; and the Caporn Street Station, Nedlands (then the laboratory of the C.S.I.R.O. Division of Wildlife Research), situated three and one third miles S.W. of the Perth G.P.O.

In many instances the trapping of the birds took place over a period of time so some were held in aviaries until their release. In the case of some of the Caporn Street birds they were confined for up to 27 days (the maximum period) in an aviary from which they could not see the sun. However there was found to be no relation between the time spent in an aviary and the ability to home and I feel confinement has no significance in this instance.

All birds were transported to their places of release in covered containers which prevented them from having any visual knowledge of the route they travelled.

RELEASES AND RESULTS

LOCAL RELEASES

(a) Salvado Road Station

(1) Three birds were released in September 1960, 3 miles to the south, at Caporn Street. One was retrapped at the Salvado Road Station 40 days after its release. These birds were originally transported to Caporn Street only so that they could be banded. The unexpected recapture of the one back at Salvado Road prompted all the other releases as all recoveries to that time showed that the two areas were separated by a zone, 1½ miles wide, in which no birds from either station had been recovered. Further, at this time of writing, 7 years later, the only recovery in this zone is that of a bird banded when a juvenile at Salvado Road, and recovered midway between the two stations.

(2) Ten birds were released at Matlock Street, Mt. Hawthorn, 2 miles to the N.E. on 3 November 1960. Four (40%) subsequently homed. Two of them were retrapped at Salvado Road 5 days after release; one was recovered ¼ of a mile from the Salvado Road Station, 89 days after its release and the other was recovered one-eighth of a mile from the Salvado Road Station, 274 days after its release. Another bird was also released with these ten, but banding data show that it was a juvenile and I have consequently disregarded it (see Discussion).

(3) Two birds were released at the corner of Warwick Street and Wanneroo Road, 7½ miles to the N. late in the afternoon on 4 November 1960. One was retrapped at Salvado Road the following morning. The other was shot at Tuart Hill, a distance of 4½ miles

S.S.E. of the release point and 3¼ miles N.N.E. of the Salvado Road Station, ca. 30 days later.

(4) Seven birds were released near the corner of Leighton Street and Stirling Highway, 6 miles to the S.W., on 4 February 1961. None are known to have homed. The only bird recovered was found dead at Victoria Park, 8¾ miles E.N.E. of the release point and 5½ miles E.S.E. of Salvado Road, 234 days after its release.

(b) Jersey Street Station

(1) Six birds were released in mid-November 1962 at Myrtle Street, Highgate, 2¾ miles to the E.N.E. Two of them (33%), were subsequently retrapped at Jersey Street on the 5th and 76th day, respectively.

(c) Caporn Street Station

(1) Four birds were released at Albert Street, South Perth, 2¾ miles to the E. on 9 September 1963. Two (50%) were retrapped at the Caporn Street Station on the 7th and 17th day, respectively. These two localities are separated by the Swan River estuary which is 1½ miles wide at this point.

(2) Eight birds, four virgin flyers and four experienced (see experiments below), were released at Henderson Park, Wembley, (adjacent to the Salvado Road Station) 3 miles to the N. The intention was to observe any indication of immediate orientation upon release but a particularly strong S.W. wind interfered with the experiment and in most cases the birds flew with the wind, with an obvious lack of any orientation in respect to home (Caporn Street). However, 5 of the birds, 3 virgin flyers and 2 experienced, were since retrapped, and the other virgin flyer seen, at the Caporn Street Station. The first virgin flyer was retrapped 2 days after its release, the second was seen 9 days after its release and retrapped 3 days later, the third was seen 35 days after its release, and the fourth was retrapped 71 days after its release and was retrapped the following day. Another (a homer from Baker's Hill) was seen at the Caporn Station 30 days after its release, seen again 5 days later, and retrapped 36 days after the second sighting. A third (a homer from Mundaring) is recorded as having homed 1 year, 79 days after its release but I am unable to locate the original record so cannot say whether it was seen, retrapped or recovered at or nearby Caporn Street. (The most probable explanation is that it was seen and although the lapse of time was recorded against the bird no record was made). The only Henderson Park release not recorded since is one which previously homed from Northam.

(3) A virgin flyer was released at Salvado Road on 9 September, 1961 and was recovered dead near the Salvado Road Station 34 days later.

LONG DISTANCE RELEASES

(a) North of Perth

(1) Ten Salvado Road birds, one of which was a homer from Matlock Street, were released at Yanchep, 32 miles to the N.N.W. in mid-March 1961. Two (20%), both virgin flyers, were recovered. One was caught and killed by a dog at the Salvado Road Station 151 days after its release. The other was recovered one year and 181 days after its release, in Money Street, Perth, 3¼ miles E. of the station. One of the birds released lingered in the Yanchep area for several weeks. (I did not record either of the introduced turtledoves *(S. senegalensis* and *S. chinensis)* during my stay there between 15 March and 29 April, 1961).

(2) Five Caporn Street birds, including two experienced, were released 10 miles north of Moora, i.e. 100 miles to the N., on 19

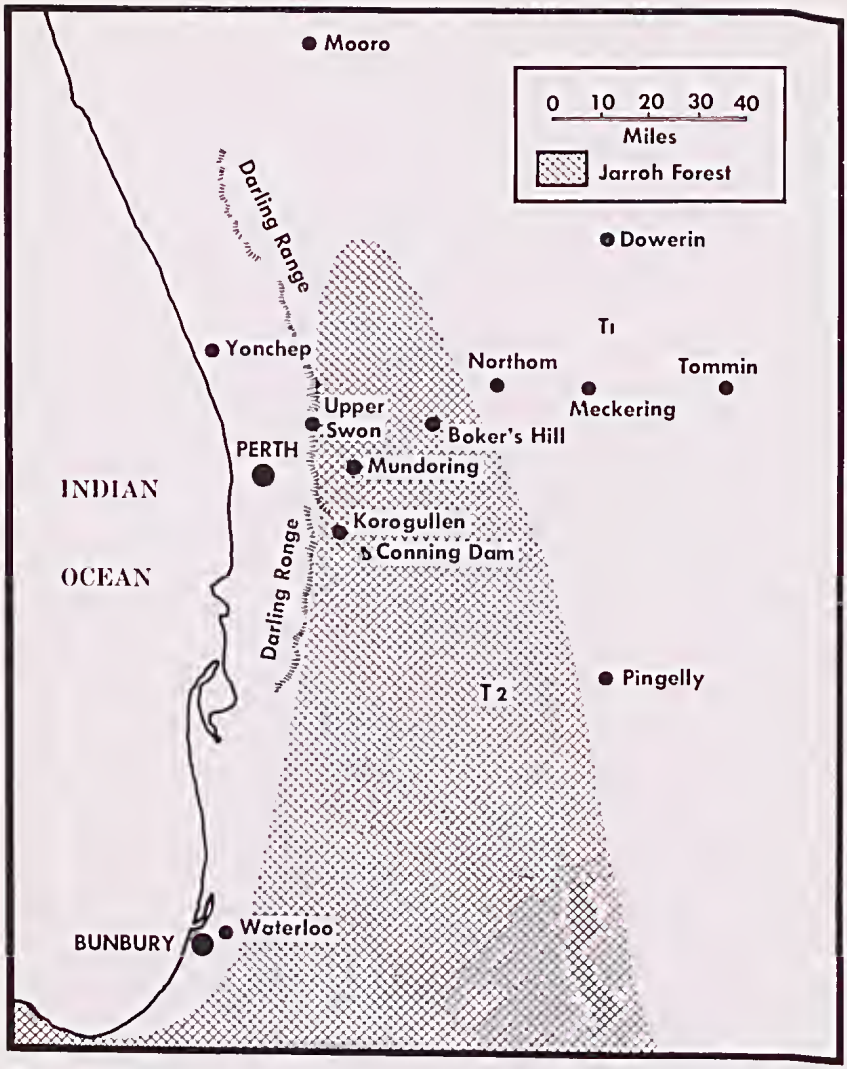

Fig. 2—Locations of long distance releases (small dots) in relation to the trapping and banding station at Perth.

February 1965 and another 8 were released on 16 March 1965. One of the experienced birds, which had previously homed from Baker's Hill, was retrapped at the banding station (Caporn Street) 12 days after its release.

(b) North-East of Perth

(1) Two Salvado Road birds, both homers from Matlock Street, were released at Upper Swan, 17 miles N.E. of Salvado Road, on 8 November 1960. One was retrapped at Salvado Road 36 days later. (Another bird was also released but the banding data show that it was a juvenile).

(c) East of Perth

(1) Fifteen Caporn Street birds were released 1 mile S.W. of Mundaring, i.e. 20 miles to the E., on 30 September 1963 and

another 5 birds on 21 October 1963. One of the birds released on 30 September was seen at the banding station 3 days later. Ten (50%) were subsequently retrapped at Caporn Street on the 14th, 23rd, 33rd, 37th, 40th, 49th, 53rd, 74th, 102nd and 313th days, respectively. Eight were of the original 15 released on 30 September and two were of the five released on 21 October. Another was recovered 3 miles N.E. of Caporn Street almost 4 years after its release on 21 October 1963.

(2) Fourteen Caporn Street birds were released 1 mile S.W. of Baker's Hill, i.e. 40 miles to the E.N.E., on 30 September 1963 and another 6 on 21 October 1963. One of the birds released on 30 September was seen at the banding station 8 days later. Seven (35%) were subsequently retrapped at Caporn Street on the 10th, 13th, 33rd, 35th, 42nd, 50th and 59th days, respectively. All were of the 14 released on 30 September.

(3) Fifteen Caporn Street birds, including a homer from Albert Street, were released 5 miles E. of Northam, i.e. 60 miles to the E.N.E. of Caporn Street, on the 30 September 1963. Another 3 were released on 21 October 1963 at the same place and another one was released near Northam, on 12 November 1963. One of the birds released on 30 September was seen at the Caporn Street Station 21 days later. Six (31%), including the experienced bird, were subsequently retrapped at the station on the 22nd, 32nd, 35th and 69th days and 1 year 5 days and 1 year 150 days, respectively. All were of the 15 released on 30 September.

(4) Fifteen Caporn Street birds, including a homer from Baker's Hill, were released 7 miles E. of Meckering, i.e. 80 miles to the E.N.E. of Caporn Street, on 12 November 1963. The experienced bird was seen at the station 14 days after its release and then retrapped 8 days later. Two others were also retrapped, on the 21st and 27th days, respectively.

(5) Twenty-nine birds, including 8 experienced, were released at Tammin, 100 miles to the E.N.E. of Caporn Street, on 3 December 1963. Three virgins and two experienced subsequently homed. One of the virgin flyers was sighted at the station 70 days after its release and then retrapped 16 days later. Another was retrapped on the 72nd day after its release and the third was recovered ¾ mile west of the station 269 days after its release. One of the experienced, which had previously homed from Northam, was retrapped at the station 71 days after its release and the other, which had previously homed from Albert Street, was retrapped 1 year and 78 days after its release. Two other birds, both of which had previously homed from Baker's Hill, were also recovered. One was recovered 17 miles south of Dowerin (see T1 on Fig. 2), the locality being 28 miles N.W. of the release point and 80 miles N.E. of the Caporn Street Station, ca. 11 days after its release. The other was shot 20 miles W. of Pingelly (see T2 on Fig. 2), the locality being 80 miles S.W. of the release point and 80 miles S.E. of the station, on about the 92nd day after its release.

(d) South-East of Perth

Six Salvado Road birds were released on the corner of McNess Drive and Albany Highway, 24 miles to the S.E. (near Canning Dam) on 26 February 1961. None are known to have homed. Only one bird was recovered and that at Brookton Road, Karragullen, a distance of 7 miles N. of the release point and 20 miles E.S.E. of Salvado Road, 10 days after its release.

(e) South of Perth

Twenty-three Caporn Street birds, including 5 experienced flyers, were released near Waterloo, i.e. 100 miles to the S., on 2 March 1965. None are known to have homed but one virgin flyer

TABLE 2—SUMMARY OF HOMING EXPERIMENTS
(Includes all retraps until closing of stations and all recoveries until March 1968)

BANDING PLACE	PLACE OF RELEASE	Distance in miles	Direction	Virgins Released	Virgins Homed	Percentage Homed	Experienced Released	Experienced Homed	Percentage Homed	Total Released	Total Homed	Percentage Homed
JERSEY ST.	MYRTLE STREET	2¾	ENE	6	2	33	—	—	—	6	2	33
SALVADO ROAD	MATLOCK STREET	2	NE	10	4	40	—	—	—	10	4	40
	CAPORN STREET	3	S	3	1	33	—	—	—	3	1	33
	LEIGHTON STREET	6	SW	7	—	—	—	—	—	7	—	—
	WARWICK STREET	7½	N	2	1	50	—	—	—	2	1	50
	UPPER SWAN	17	NE	—	—	—	2	1	50	2	1	50
	CANNING DAM	24	SE	6	—	—	—	—	—	6	—	—
	YANCHEP	32	NNW	9	1	11	1	—	—	10	1	10
CAPORN STREET	ALBERT STREET	2¾	E	4	2	50	—	—	—	4	2	50
	HENDERSON PARK	3	N	4	4	100	4	3	75	8	7	87
	SALVADO ROAD	3	N	1	—	—	—	—	—	1	—	—
	MUNDARING	20	E	20	10	50	—	—	—	20	10	50
	BAKER'S HILL	40	ENE	20	7	35	—	—	—	20	7	35
	NORTHAM	60	ENE	18	5	28	1	1	100	19	6	32
	MECKERING	80	ENE	14	2	14	1	1	100	15	3	20
	TAMMIN	100	ENE	21	3	14	8	2	25	29	5	17
	MCORA	100	N	11	—	—	2	1	50	13	1	8
	WATERLOO	100	S	18	—	—	5	—	—	23	—	—

was recovered 3 years later at Bunbury some 7 miles to the west of Waterloo.

DISCUSSION

PERIODS OF TRAPPING AT THE STATIONS

Jersey Street Station: Since the release of the birds on 12 November 1962 trapping has been spasmodic. Trapping took place for about 1 month after their release, for about 1 month from late January to late February 1963, for about 5 months from mid-August to mid-December 1963. for about 1 month during July and August 1964 and for about 2 months between mid-February to mid-April 1965. This would give a total trapping period of about 10 months.

Salvado Road Station: This station operated from the time of release of the first bird on 2 September 1960 until mid-December 1961. This allowed the Matlock Street, Warwick Street and Upper Swan releases about 13 months in which to be retrapped, the Leighton and Canning Dam releases about 10 months and the Yanchep releases about 9 months.

Caporn Street: From the time of the first Mundaring, Baker's Hill and Northam releases on 30 September 1963 trapping was maintained daily for a period of 2½ months (the Albert Street releases had an additional time of 3 weeks). From mid-December 1963 to end January 1964 trapping was restricted to sporadic weekend activity, except for 7 continuous days over Christmas and the New Year. From February 1964 to October 1964 trapping was conducted (in between other duties) by Mr. A. G. Mathews on weekdays. No further trapping was done until mid-February 1965 when sporadic weekend trapping continued until mid-April 1965. For a few months after this intermittent observing for colour banded individuals was conducted. Hence the earlier Caporn Street releases had considerable opportunity to be retrapped or observed but the Moora and Waterloo releases only had a month or so in which to be retrapped and a few months in which to be observed.

As it is normal for some juveniles to disperse to other areas after being reared, only adult birds were used in the experiments (with the exception of the Upper Swan and Matlock Street releases) as their failure to return could be directly attributed to a lack of desire, which differs significantly from inability. (The juvenile which was released at Matlock Street was recovered at Mt. Yokine, a distance of 1¾ miles N.N.E. of Matlock Street and 3½ miles N.E. of Salvado Road, 1 year 89 days after its release and it is known that young Homing Pigeons *(Columba livia)* readily adopt an area to which they are transplanted).

Adult Homing Pigeons may also adopt a new locality when mated to a native of the new area and behaviour of this nature could account for the Waterloo release recovered at Bunbury, and for the Yanchep release recovered 3¼ miles E. of home and the Mundaring release recovered 3 miles N.E. of home, as it could be contended that the birds, having returned to a similar type of environment, were then influenced to adopt new territories (assuming that the two latter birds had not actually homed—see Table 1).

The Senegal Dove is a species which displays much intraspecific aggressiveness, and although the birds may gather in small flocks when feeding on the ground, they never flock in flight. The birds are individualists in flight, and should a feeding flock be disturbed the birds scatter in various directions, some coming to perch nearby, others continuing flight until out of sight. From this it is deduced that each bird would have attempted to return home by itself; there would be no following of a leader by

birds with lesser abilities or desires, with the possible exception that a mated pair had by chance been released together. However, this same intra-specific aggressiveness does not necessarily mean that a displaced bird would be forced from the locality by other resident individuals of the species, such as would be the case in a territorially aggressive species such as the Western Magpie *(Gymnorhina dorsalis)*. In fact I feel that no significant pressure would be exerted on a displaced bird by other individuals resident in the locality, particularly in view of the sparseness of the species in the forest and wheatbelt areas. Natural hazards such as hawks could possibly reduce the number of potential homers and this fact could be kept in mind when examining the results for the longer distances and in view of the sometimes lengthy lapse of time between the release and the recovery of some of the homers.

Additional hazards of Perth's metropolitan area, such as the domestic cat and vehicular traffic, could also account for some homers not being recovered; though possibly these two factors would result in more birds coming to public notice.

As the birds had no known nests or loft which could be watched we were completely dependent upon retrapping, recovery by the general public, or, in the case of colour banded birds, upon the sighting of the birds at the banding stations, to gain the knowledge that any bird had homed and the lapse of time. Consequently the first retrapping or sighting of a bird does not necessarily mean that it had only just returned, though it is perhaps an indication in the Caporn Street releases as the Caporn Street Station was a particular attraction to birds because of continuous free-feeding. The sighting or retrapping of a bird some considerable time later, is much less an indication, due to intermittent trapping at the stations (see details appertaining to each banding station). It will also be realised that the number of birds sighted and recovered, either by retrapping or by members of the public, will be less than the number of birds that have homed.

BEHAVIOUR OF BIRDS UPON RELEASE

After transportation to the release locality the birds were either released singly or simultaneously. Mostly they flew for only short distances before coming to perch, and on nearly all occasions birds released together scattered in various directions. The first group of birds released at Moora (100 miles N) however, all headed southwards, but this could be attributed either to the position from which they were released, or chance.

The only indication of orientation comes from the observations of Miss C. A. Nicholls who, when she released the birds at Waterloo (100 miles S), stated: "They radiated out of the boxes and flew immediately to tall gum trees on either side of the road. After 5 minutes two birds left a tree simultaneously and flew strongly away to the north, and were lost to sight."

Miss Nicholls' other observation, that "the remaining birds sat quietly in the trees and looked about," is typical of the behaviour of most of the birds when released.

TOPOGRAPHY OF THE PERTH AREA

Landscape recognition has been excluded as a means of homing, but birds may be influenced by landscape features.

The principal topographical features of the Perth area are the Darling Range Plateau in the east, the Indian Ocean in the west, the lower reaches (broadwaters) of the Swan River estuary, and the chain of lakes extending both north and south of Perth.

The Swan Coastal Plain is generally considered as being flat, but the larger lakes and the Swan River broadwaters would not

be visible to a low-level flyer, such as this species which does not normally ascend to any great height above tree top level, until the bird was virtually upon them and so may not be as influential as could be expected. However any bird emerging from the Darling Range Plateau east of Perth would have an uninterrupted view of Perth and, similarly, birds emerging from the Darling Range Plateau at any considerable distance north or south of Perth could be influenced by large lakes in those regions.

The Indian Ocean would be a definite negative guide in that it would compel a bird to satisfy its homing urge in another direction as well as removing some 90deg. of area if it then searches parallel to the coast.

The Darling Range scarp could also have a similar effect on birds that were released or moved themselves to the west of it, and in conjunction with the Indian Ocean could form a channel some 12 miles in width which would considerably help any bird, involved in random search in a homeward direction, to locate its home territory. In addition, its prominent features could help a bird in the coastal plain to gauge the approximate distance of its home territory from it.

THE BASIS OF HOMING

Considering the inconsistency of the trapping operations coupled with the reliance upon a bird's recovery by members of the public, the percentage of homers implies that individuals possess an efficient means of locating their home territory (Table 2). Possibly a basic sense of direction complements a sustained searching, which in this locality may have been aided by the topography. Or perhaps, displacement induces a stress within the bird which is only relieved as the bird moves nearer to home, or is aggravated if the bird does not move relative to home. It is significant perhaps that all birds recovered elsewhere than in the vicinity of their home areas were never further from home than their place of release. For instance, the two Tammin birds recovered near Dowerin and Pingelly, though obviously not on a direct homing route, were 20 miles closer to home.

Sustained searching could have eventually got them home and Barlow (1964) has drawn attention to the significance of such an arbitrary homing route if it is relative to inertial navigation.

The difference in time between two birds homing, in those instances where it could be a reliable gauge, could undoubtedly be attributed to differences in direction initially and subsequently taken by the birds when random search, or any allied method, is involved. It could also be attributed to differences of desire or urgency that the birds feel. For instance, the differences that would exist between a bird with an active nest and one that only felt a need to return home The extent to which nests were an incentive to home is unknown, but the species breeds locally throughout the year, though at a minimum during the winter months, and hence it is likely that some birds had an active nest to return to.

SUGGESTIONS

The species is an ideal subject for any individual, group or school project.

Further homing work in an area with less prominent topography would be desirous; or, if it were done locally, with the Domestic Pigeon *(Columbia livia)* as a control. In addition, it would be interesting to know if aviary-reared individuals, transported and released when fully adult, possessed sufficient urge and ability to return to the aviary.

CONCLUSION

The experiments show that individual Doves have a definite urge, possibly a sustained one, to return to their home territory. They also exemplify these birds' ability to traverse extensive areas of unknown and unfamiliar types of country, i.e. the 45 mile wide strip of jarrah forest extending along the eastern edge of the Darling Ranges and the cultivated wheatbelt to the east of it, while endeavouring to relocate their home ground.

That such a sedentary species should have the urge and ability to return home after displacement, is interesting, and a deeper understanding of both factors is desirable.

ACKNOWLEDGEMENTS

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EXCURSION

HARTFIELD PARK, FORRESTFIELD

The excursion of the Western Australian Naturalists' Club to this reserve on October 8, 1967, was a success in every respect. Though inclement weather threatened earlier in the day, it turned out fine and genial and the members, who had gathered at the corner of Hale and Hardey Roads at 11.00 a.m., enjoyed a congenial picnic lunch under the shade of a gum tree after a preliminary natural history reconnaissance. The main work was done in the afternoon. Hartfield Park is approximately 400 acres in area, including a portion excised for the Beechboro-Gosnells Highway which will pass through the western corner. It comprises reserves Nos. 19774 and 17098, having a frontage of 58 chains to Hale Road and 68 chains to Hartfield Road. They are class "A" Reserves vested in the Kalamunda Shire Council for purposes of recreation. A strip alongside Hartfield Road is being developed for sporting activities but the bulk of the area is retained by the Shire Council as a nature reserve, and signboards erected along